

Response to Comments from Alcoa Inc., on Site-Specific Water Quality Criteria (WQC) for Aluminum: 2005 – Update.

July 25, 2005

IDEM has reviewed the comments dated July 6, 2005 received from Alcoa through their Counsel on the above subject and offers the responses to each of the comments as follows:

Response to Comment # 1.

In the 1988 Aluminum Criteria Document, USEPA had used Striped Bass (*Morone saxatilis*) and Brook trout (*Salvelinus fontinalis*) data from 7 days and 60 days tests, respectively, to lower the calculated Final Acute Value (FAV) of 1,496 ug/L to 87 ug/L as the chronic value to protect both Striped bass and Brook trout, see the text on Page 6 and Table 3 of USEPA 1988 Aluminum Criteria Document.

IDEM realizes that Striped bass is not a resident species in Indiana warm waters, but surrogates of this species such as *Morone chrysops* and Largemouth bass (*Micropterus* species) and some other species such as Goldfish and Narrow-mouthed toad etc., are present in Indiana warm waters and these need to be protected. The EC₅₀ (Effective Concentration to cause 50% mortality) in these species in 7 to 8 days tests ranged from 50 to 170 ug/L, see Table 6 of 1988 Aluminum Criteria Document and WQC Summary Table 2 from IDEM's March/April 2005 communication. At this time these were the only toxicity data available to IDEM for these species. Therefore, instead of using 50 or 170 ug/L as the representative chronic value from the above mentioned species (see IDEM's WQC Summary Table 2), as did the USEPA (see 1988 Aluminum Criteria Document, Table 3, Page 22), IDEM as in the past (2002) had used 174 ug/L from a 7 day test as the representative chronic value from Striped bass (*Morone saxatilis*) to protect its surrogates (White bass-*Morone chrysops*, Largemouth bass-*Micropterus salmoides*, Smallmouth bass-*Micropterus dolomieu*, etc.) and several other species mentioned above that are present in Indiana warm waters and beyond. In fact, if the toxicity data for the same species had come from tests longer than 7 or 8 days, the numbers would have been much lower than 174 or 170 ug/L and would have resulted in a much more lower chronic value than the one (174 ug/L) IDEM had proposed in 2002 or now in 2005 as the site-specific chronic criterion for Aluminum. Also, lowering of the chronic value for Aluminum by IDEM is in concurrence to the 1994 USEPA's Recalculation Procedure guidance on water quality criteria (WQC) which states that, "The calculated FAV, CMC and/or CCC must be lowered, if necessary, to (1) protect an aquatic plant, invertebrate, amphibian, or fish species that is a critical species at the site --". In light of this USEPA policy on Recalculation Procedure for the derivation of site-specific criterion, IDEM feels comfortable with the proposed 174 ug/L chronic criterion value for aluminum and stands by it.

Response to Comment # 2.

No comments, Alcoa self corrected the FAV calculation from 1982.4 to 1882.4 for typographical error.

Response to Comment # 3.

IDEM had already offered the various reasons and explanations in the previous communication for not accepting the recalculated Acute-Chronic (A-C) Ratio of 4.79 derived by Alcoa from Survival and Growth endpoints for Fathead minnow (FHM) data (see Pages 3 and 4 of IDEM's earlier communication). According to USEPA, the original 10.64 A-C Ratio for FHM from Growth endpoint is the correct one and the A-C Ratio of 4.79 calculated as the Geometric mean from Survival and Growth endpoints is unacceptable to both IDEM and the USEPA for one or more reasons. According to USEPA, a MATC or chronic value of 5,776 ug/L (Geometric mean, rounded to 5,780 ug/L) derived by Alcoa from a NOEC of 4,700 ug/L and 7,100 ug/L as LOEC and used in A-C Ratio calculations is not acceptable because this would cause about 19.2% weight reduction in FHM. This extrapolation is based on about 11.4% weight reduction at 4,700 ug/L and about 30% significant weight reduction at 7,100 ug/L in FHM (see Kimball's Manuscript).

Also, the A-C Ratio of 4.79 derived by Alcoa from Survival and Growth endpoints comes from an insensitive FHM species (Sensitivity Rank 7, see IDEM's WQC Table 3) and for the same reason USEPA was not in agreement even to use the original A-C Ratio of 10.64 for FHM in criteria calculations for Aluminum. For more information on an acceptable or an unacceptable A-C Ratio and its use in criteria calculations, see Response to Comment # 6.

Response to Comment # 4.

Yes, after having discussions just this year with USEPA, regarding which new acute toxicity data for aluminum are acceptable and which one are not and as mentioned on page 4 of IDEM's earlier communication, IDEM had added the toxicity data (9,190 ug/L as acute value) for one species (*Crangonyx* sp.) and lowered the acute numbers for the *Dugesia* sp., from >23,000 to >16,000 ug/L to recalculate the site-specific WQC for Aluminum.

Based on additional discussions and the information provided to IDEM by USEPA, IDEM was not able to use the data from two other species (*Daphnia magna* and *Tubifex tubifex*). The exact reasons for not using the data from these two species were provided on page 4 of IDEM's earlier communication and the chief among them was the use of Aluminum salt as the test material that contained ammonia. As did the USEPA in written communication with IDEM, IDEM had used a similar phrase to identify the test substance. In IDEM's view use of one or the other name for the constituent part in the test substance for aluminum does not change the fact or make the data from these two species any more valid or acceptable for recalculation of site-specific criteria for Aluminum.

Response to Comment # 5.

IDEM agrees Dissolved Oxygen value of 49.3% was not stated in the original paper by Khangarot and Ray (1989) for *Daphnia magna*, but this was provided to IDEM by USEPA. In this regard and on other topics, reference to consultation with USEPA was already stated at

start of the Page 4 (see IDEM's earlier communication) and it was redundant to repeat this after each item being discussed on that page. Apparently USEPA had detailed information from this publication and had recommended to IDEM not to use the data from it. Additionally, similar to the other study with *Tubifex*, the Aluminum salt used as the test substance in *Daphnia magna* test contained ammonia and this was another reason not to use the data from *Daphnia* test in site-specific criteria calculations for Aluminum either back in 2002 or now in 2005.

Response to Comment # 6.

IDEM knows that if one or more A-C Ratios differ by a factor of 10 that A-C Ratio is not usable and concurs with the statement on it from Alcoa in Comment #3. Alcoa had derived an A-C Ratio of 4.79 for FHM, an insensitive species, from both Survival and Growth endpoints, which differed from the A-C Ratio of 51.47 for *Daphnia magna* by a factor of >10. Therefore, it made sense not to use the A-C ratio for *Daphnia magna* and IDEM had alluded to this effect in paragraph # iv on page 4 of the earlier communications. But the fact is that IDEM had not agreed to the recalculated A-C Ratio of 4.79 for FHM as the geometric mean from Survival and Growth endpoints for one or more reasons. According to USEPA, it is not appropriate to calculate A-C Ratio based on Survival and Growth results, but rather, lower of the two results (Survival or Growth) should be used to protect against the most sensitive adverse effect. As per the calculations by USEPA, the effective concentrations (2,300 ug/L with 7.1% weight reduction as NOEC and 4,700 ug/L with 11.4% weight reduction as LOEC) for the sensitive Growth endpoint had resulted in a MATC or chronic value of 3,288 ug/L with an average weight reduction of just 9.3% and an A-C Ratio of 10.64 for FHM (LC₅₀ 35,000 ug/L/3,288 ug/L MATC for Growth), but not 4.79 as derived by Alcoa from Survival and Growth endpoints (see also Response to Comment # 3 above).

On the topic of A-C Ratio in paragraph #4 on Page 4 of earlier communication, IDEM was trying to make another point. Instead of recalculating a new A-C Ratio of 4.7, one could have used the existing A-C Ratio of 51.47 for *Daphnia magna* from the USEPA 1988 Aluminum Criteria Document, but instead Alcoa by recalculating the A-C Ratio for FHM was trying to pick and choose the A-C Ratio for criteria calculations for Aluminum. In either case, the A-C Ratios of 51.47 for *Daphnia* and 4.7 and for FHM not only differ by a factor >10, but both the values come from insensitive species (Sensitivity Rank 8 and 7, see IDEM's WQC Table 3) and, therefore, both of these A-C Ratios are unacceptable for site-specific criteria calculations for Aluminum. A brief discussion in not using the A-C Ratio from insensitive species is given on page 6 of the USEPA 1988 Aluminum Criteria Document. The 1985 USEPA Guidance Document on Criteria Calculations further elaborates on this topic. In Section VI, K, 1 of the USEPA Guidance Document (on Final Chronic Value topic) it states that ---, "the Final Acute-Chronic Ratio should be calculated as the geometric mean of the acute-chronic ratios for species whose SMAVs are close to the Final Acute Value". Based on this Guidance from USEPA, the SMAVs (Species Mean Acute Values) of 38,200 ug/L and 35,000 ug/L for *Daphnia* and FHM, respectively, are far from being close to the IDEM recalculated site-specific Final Acute Value (FAV) of 1,974 ug/L for Aluminum, and this alone makes the A-C Ratios calculated from either species as unacceptable in criteria calculations for aluminum.

Response to Comment # 7.

Based on Indiana Rule 327 IAC 2-1-8.2 (2(B), IDEM had discussed the eventuality of possible use of data from non-resident species (*Asellus*) as representative of resident species in criteria calculations and had demonstrated the criteria from such calculations for illustration purposes only. The fact that IDEM had not recommended the site-specific criteria from such calculations for aluminum it is not necessary to add or change the discussion on this topic in IDEM's earlier communication.

Response to Comment # 8.

As per the recent discussions with USEPA, USEPA stands by the A-C ratio of 10.64 derived from FHM sensitive Growth endpoint. Therefore, the possible chronic criterion of 84.87 ug/L obtained by dividing the FAV of 1,986 calculated in 2002 by 23.4 as the geometric mean of A-C Ratio of 10.64 and 51.47 from FHM and *Daphnia magna* respectively, is correct. IDEM had used these calculations for illustration and discussion purposes only as opposed to the chronic criterion of 439.86 ug/L obtained by Alcoa from FAV of 2,107.52 ug/L divided by an unacceptable A-C Ratio of 4.79 for FHM developed from Survival and Growth endpoints. But unfortunately either A-C Ratio including the one derived by Alcoa is unacceptable in criteria calculations for the reasons discussed above.

Response to Comment # 9.

As pointed out by Alcoa, IDEM has changed the typographical errors in GMAVs 49,000 and 47,000 listed for *Perca* and *Ictalurus* (Sensitivity Rank 10 and 9) to the correct GMAVs of 49,800 and 47,900 respectively. But these changes had no effect on the water quality criteria calculated from rest of the data. By looking into the IDEM's WQC Table 3 provided in earlier communication one could easily see that in criteria calculations all statistical numbers for the parameters identified by Alcoa were rounded to 4 decimal places. But as requested by Alcoa, an exclusive "Note" has been added to the IDEM's WQC Table 3 to state the same (see the new WQC Table 3 attached). At the same time IDEM has rechecked the criteria calculations once again but the site-specific water quality criteria (rounded off to whole numbers) for Aluminum calculated by IDEM (see below) remained unchanged from the previous criteria numbers provided to Alcoa in the earlier communication.

| | |
|---|----------------------------|
| Final Acute Value (FAV) | = 1,974 ug/L |
| Acute Criterion (AAC), FAV/2 | = 987 ug/L |
| Chronic Criterion (CAC), FAV/2 as the A-C Ratio | = 987 ug/L (174.00 ug/L)/* |

*/ CAC lowered to 174 ug/L. For details see WQC Summary Table 2 as well as the text in IDEM's earlier communication and the associated discussion on this topic in this 'Response to Comments'.

TABLE 3
Recalculation of Site-Specific WQC for Aluminum (Al), 2005

| Genus | GMAV (ug/L) | Rank | Cum. Prob. P = (Rank/n+1) | Sq.Rt. (P) | In (GMAV) | In (GMAV)2 |
|---------------------|----------------|------|------------------------------|------------|-----------|------------|
| <i>Tanytarsus</i> | >79,000 | 12 | | | | |
| <i>Lepomis</i> | >50,000 | 11 | | | | |
| <i>Perca</i> | >49,800 | 10 | | | | |
| <i>Ictalurus</i> | >47,900 | 9 | | | | |
| <i>Daphnia</i> | 38,200 | 8 | | | | |
| <i>Pimephales</i> | 35,000 | 7 | | | | |
| <i>Physa</i> | 30,600 | 6 | | | | |
| <i>Acroneuria</i> | >22,600 | 5 | | | | |
| <i>Gammarus</i> | 22,000 | 4 | 0.3077 | 0.5547 | 9.9988 | 99.9760 |
| <i>Dugesia</i> | >16,600 * | 3 | 0.2308 | 0.4804 | 9.7172 | 94.4240 |
| <i>Crangonyx</i> @ | 9,190 | 2 | 0.1538 | 0.3922 | 9.1259 | 83.2821 |
| <i>Ceriodaphnia</i> | 2,648 | 1 | 0.0769 | 0.2773 | 7.8816 | 62.1196 |
| | | | ----- | ----- | ----- | ----- |
| | | | 0.7692 | 1.7046 | 36.7235 | 339.8017 |

* Lowered to from >23,000 as correct value.

@ Added to the National Tox Database.

Note: In criteria calculations, all statistical numbers are rounded to 4 decimal places.

| | | | | |
|--------------------|---|-----------|---|----------|
| T | = | 4 | | |
| \sum In (GMAV) | = | 36.7235 | S | = 7.8654 |
| \sum In (GMAV)2 | = | 339.8017 | L | = 5.8290 |
| \sum P | = | 0.7692 | A | = 7.5877 |
| \sum Sq. Rt. (P) | = | 1.7046 | | |
| Where \sum | = | Summation | | |

A-C Ratio = 2.00 (Default Value, see 1988 EPA Criteria Document for Aluminum)
(*Daphnia* 51.47, *Ceriodaphnia* 0.9958, *Pimephales* 10.64, see 1988 EPA, Criteria Document, Table 2, Page 20)

| | | | | |
|-----|------------------------|-----------------|---|----------------------------------|
| | | | | <u>Rounded Off to Whole Nos.</u> |
| FAV | = eA (7.5877) | = 1973.770 ug/L | → | 1974 ug/L |
| AAC | = FAV/2 | = 986.885 ug/L | → | 987 ug/L |
| CAC | = FAV/A-C Ratio (2.00) | = 986.885 ug/L | → | 987 ug/L (174 ug/L)/* |

*/ Chronic Aquatic Criterion (CAC) = **174.00 ug/L**
(Lowered to protect Striped bass surrogate species- White bass- **Morone chrysops** and Largemouth bass- **Micropterus** species etc., that are present in Indiana/ Midwest and beyond, see 1988 EPA Criteria Document for Aluminum, Page 6, Table 3, and Table 6 for Tox data)

U.S. EPA Calculated WQC for Aluminum:

| | | |
|---|---|-------------------|
| FAV | = | 1496 ug/L |
| AAC (FAV/2) | = | 748 ug/L |
| CAC (FAV/Default A-C Ratio (2.00)) | = | 748 ug/L |
| Final Chronic Value (CAC) | = | 87.00 ug/L |
| (Lowered to protect Brook trout and Striped bass, see 1988 EPA Criteria Document for Aluminum, Page 6 & Table 3.) | | |

Ghias: July 2005

Aluminum Site-Specific WQC Calculations Details:

$$S^2 = \frac{\sum \{ (\ln \text{GMAV})^2 \} - \sum \{ (\ln \text{GMAV}) \}^2 / T}{\sum (P) - \sum \{ (\sqrt{P}) \}^2 / T}$$

$$S^2 = \frac{\sum \{ (\ln 339.8017)^2 \} - \sum \{ (\ln 36.7235)^2 \} / 4}{\sum (0.7692) - \sum \{ (\sqrt{1.7046}) \}^2 / 4}$$

$$= \frac{339.8017 - 337.1539}{0.7692 - 0.7264}$$

$$= \frac{2.6478}{0.0428} = \sqrt{61.8645}; \quad \mathbf{S = 7.8654}$$

$$L = \{ \sum (\ln \text{GMAV}) - S (\sum (\sqrt{P})) \} / T$$

$$\mathbf{L} = \{ (36.7235) - 7.8654 \times 1.7046 \} / 4$$

$$= \{ 36.7235 - 13.4074 \} / 4$$

$$= 23.3161 / 4$$

$$= \mathbf{5.8290}$$

$$A = S \sqrt{(0.05)} + L$$

$$\mathbf{A} = 7.8654 \times 0.2236 + 5.8290$$

$$= 1.7587 + 5.8290$$

$$= \mathbf{7.5877}$$

$$\mathbf{FAV} = e^A$$

$$= e (7.5877) = \mathbf{1973.77 \quad (1974)}$$